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Exits in the gasoline market: Evidence from Austria

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Abstract

The retail gasoline market is going through a process of restructuring and consolidation in many developed economies. During the past decade, a large number of gasoline stations have been closed down. The present paper aims to investigate this process. One of the key characteristics of the retail gasoline market is that competition is localised, and this spatial dimension of competition has to be taken into account when investigating the (binary) decision of whether or not to exit from this business. The results of a probit model estimated on the Austrian retail gasoline sector suggest that the degree of spatial differentiation (distance between gasoline stations) as well as other station-specific and regional characteristics can explain parts of the actual exit behaviour observed between 2003 and 2011.

Keywords

Exit decisions, gasoline retailing, probit model, spatial competition.

JEL Classification: C25, L1, L22, L81

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1. Introduction

Economists have long recognised a central tradeoff in spatial location choice: *stealing* customers by locating closer to competitors comes at the cost of intensified price competition (Marshall, 1920). While a large volume of theoretical research analyses strategic location decisions, only very few empirical studies explicitly consider the spatial dimension when investigating firms' entry and/or exit decisions (recent examples include Seim, 2006 and Watson, 2005). The present paper uses a unique panel data set of retail gasoline stations in Austria for the period from 2003 to 2011 to investigate firms' exit decisions econometrically. The geographical location of each gasoline station is linked to information on the Austrian road system, which allows us to take into account the spatial dimension of competition (distance between gasoline stations).

Investigating exits in a spatial context in the retail gasoline market is particularly interesting since competition is highly localised in this market. Outlets compete with close rivals only; this corresponds nicely to theoretical models of spatial competition in industrial organisations. Further, market structure is characterised by a few large companies or retail chains, so-called *majors*, dominating the market and operating outlets in most local markets. These *majors* compete with a large number of small firms (*independent* or *unbranded* stations) that are only active in a few or even in one local market only. Finally, gasoline is a homogeneous product with respect to its chemical properties and stations differentiate location as well as by providing additional services (shops, opening hours, attendant service etc.), which is explicitly taken into account in the empirical analysis.

The Austrian retail gasoline market has experienced considerable structural changes. According to the annual reports of the Austrian Economic Chamber, the number of gasoline stations decreased from 4,061 in 1988 to 2,575 stations at the end of 2011. This corresponds to a decline of almost 37%.[1] Between 2003 and 2011, 10.9% of stations were shut down and 29.6% either left the market or changed the brand. The aim of this paper is to shed light on structural changes in the Austrian retail gasoline market. In particular, we investigate the competition structure and the characteristics of stations with respect to the exit probability. Note that individual exit decisions are binary in nature (exit *yes* or *no*). To investigate discrete exit choices, we apply a probit model on station-level data for the Austrian gasoline market. The rest of the paper is organised as follows: in section 2, we describe the data, section 3 reports the empirical results and section 4 concludes.

2. Data

The empirical analysis utilises three different data sources. The first contains information on the location as well as additional characteristics of all gasoline stations in Austria in 2003 collected by Experian Catalist. The second data set contains the same information for all active stations in 2011. This information is obtained from Petrolview, a split-off company from Catalist.[2] By merging the two data sets, we are able to identify the structural changes (exits of gasoline stations) between 2003 and 2011.

We categorise stations into four groups: still active, changed brand, shut down and new station. If a station is active both in 2003 and in 2011 in the same location and under the same brand, it is categorised as *still active*. The category *changed brand* represents stations that operate in the same location but that changed their brand between 2003 and 2011. If a gasoline station no longer operated in 2011, it is classified in the third category, *shut down*. Stations that are only present in 2011 but did not exist in 2003 represent market entries and thus were classified as *new stations*. For the purpose of analysing the probability of exit for one station, we defined the binary dependent variable as follows:

$$exit = \begin{cases} 1, \text{ if category } \textit{changed brand} \text{ or } \textit{shut down} \\ 0, \text{ if category is } \textit{still active}. \end{cases} \qquad (1)$$

The third data set contains information on the population and size of the municipalities and districts in

[1] Similar changes have been observed for the US and Canadian gasoline markets (Eckert and West, 2005).

[2] See www.catalist.com and www.petrolview.com for company details.

this region, as a part of the population census collected by the Austrian statistical office in 2001.

Table 1 reports some initial descriptive evidence on the dependent variable (exits of gasoline stations) by differentiating between branded and unbranded stations. A gasoline station is classified as *Branded* if this station belongs to one of ten major brands in the Austrian retail gasoline industry and as *Unbranded* otherwise. Of all 837 station exits between 2003 and 2011, the majority (73.72%) are by branded stations. However, the table suggests that the share of exiting stations seems to be larger for unbranded stations compared with branded stations. Whereas 33.64% of all unbranded stations exited, only 28.45% of all branded stations left the market. In the econometric model, we test whether there is an asymmetry in the exit probability of branded and unbranded stations and if the presence of an unbranded station affects the exit probability of branded stations, as suggested by Eckert and West (2005).

Table 1 The number of station exits between 2003 and 2011 by type of station

	Unbranded	*Branded*	*Total*
Exits	220	617	837
Percentage of all Exits	26.28%	73.72%	100%
Percentage in station category	33.64%	28.45%	

Remarks: The total number of stations is 2822, with 2,169 (654) stations classified as *branded* (*unbranded*).

Table 2 reports the descriptive statistics for all the metric and dummy variables included in the empirical model. The variable *Samebrand* indicates how many of the ten nearest neighbours of one station operate under the same brand. Following Götz and Gugler (2006), we expect a positive effect of this variable on the exit probability since a higher market concentration is argued to lead to more exits. *No. of Independents* measures how many of the ten nearest neighbours are independent stations. Assuming that independent competitors set prices more aggressively suggests a positive impact of this variable on exit probabilities. *Average Distance* represents the average distance to the ten nearest neighbours. We expect this variable to lower the exit probability as a greater distance to neighbours reduces the intensity of competition. The variable *Dealer Owned* equals one if a station is operated by a dealer and zero otherwise.

The probability of exiting the market might also be related to the characteristics of the individual gasoline station. The variable *shop* indicates if the station has a convenience shop. The dummy variable *24h* equals one if the station is operated non-stop and zero otherwise. Further, we include a group of dummy variables *(Speed: < 40 km/h, Speed: 40–60 km/h, Speed: 61–80 km/h, Speed: 80–100 km/h, Speed: >100 km/h),* which indicate the speed limit of the street were the station is located. The category *Speed: >100 km/h* represents stations that are located on highways and serve as the reference category. *Attendant Service* is also a binary explanatory variable containing information on whether the station offers an attendant service or not. The variables *Size* $\leq$ *800* m^2*, Size: 800–2000* m^2 and *Size* > *2000* m^2 are dummy variables that measure the ground surface of the location. Again, *Size* > *2000* m^2 as the reference category is excluded from the estimation.

In addition to these station characteristics, we also consider proxy variables for regional differences in demand: *Commuters* represents the ratio of incoming plus outgoing commuters to the population at the municipality level and *Popdens* measures the population density of the municipality level in 1000 inhabitants per km^2. For both variables, we expect to find a negative impact on the probability of exit.

3. Empirical Model and Estimation Results

Let $\pi_{i,t}\left(z_i, c_{i,t}, m_{i,t}\right)$ denote the profits earned by station i at time t with $t \in (1, \infty)$. These profits are a function of station-specific characteristics (z_i), the degree of competition in the local market of station i ($c_{i,t}$) as well as other local market characteristics ($m_{i,t}$) that are exogenous to the individual station. An exit takes place when stations realise that the expected discounted present value of remaining in the market $E\left[\Pi_i\right] = \sum_{t=1}^{\infty} \frac{E\left[\pi_{i,t}\left(x_i, c_{i,t}, m_{i,t}\right)\right]}{(1+r)^t}$ is less than the sell-off value ($s_{i,t}\left(z_i, c_{i,t}, m_{i,t}\right)$), where r is the market-determined, risk-adjusted discount rate and $E[\cdot]$ is the expectation operator. The sell-off value is influenced by station-specific as well as local market characteristics. The exit rule thus is based on a comparison between the sell-off value ($s_{i,t}\left(z_i, c_{i,t}, m_{i,t}\right)$) and the optimal expected discounted profit $E\left[\Pi_i\right]$. If the first term is greater than the second $s_i > E\left[\Pi_i\right]$, the firm goes out of the market and we observe $exit_i = 1$, otherwise, it remains and we observe $exit_i = 0$.

The difference between the sell-off value and expected discounted sum of profits for each station can be defined as a continuous variable $exit_i^* \equiv s_i - E[\Pi_i] = \boldsymbol{x}'\boldsymbol{\beta} + \varepsilon_i$, which we assume to be a linear function of k explanatory variables $\boldsymbol{x}$. This vector includes station-specific characteristics (z_i), measures of the degree of competition (c_i) as well as local market characteristics (m_i). $\boldsymbol{\beta}$ is a vector of dimension $k \cdot 1$ of parameters that are to be estimated and ε_i is an error term that is distributed normally with zero mean and a variance (normalized to unity). Note that $exit_i^*$ is unobservable. We observe the actual exit behaviour is related to $exit_i^*$ as follows:

$$exit_i = \begin{cases} 1 & \text{if } exit_i^* > 0 \\ 0 & \text{else.} \end{cases} \tag{2}$$

The distributional assumptions for the error term allow us to state the probabilities of the event as $\Pr\left(exit_i = 1 \middle| \boldsymbol{x}\right) = \Phi\left(\boldsymbol{x}'\boldsymbol{\beta}\right)$, where $\Phi(\cdot)$ denotes the cumulative distribution function of a standard normal variate (see Wooldridge, 2003 for a detailed description of the probit model).

Owing to the non-linearity in the normal probability distribution, the parameter estimates $\boldsymbol{\beta}$ do not have the same interpretation of marginal effects as in standard linear models. The change in the dependent variable $exit_i$ due to changes in the explanatory variable x_i (marginal effect) is

$$\frac{\partial E[exit|\boldsymbol{x}]}{\partial \boldsymbol{x}} = \varphi\left(\boldsymbol{x}'\boldsymbol{\beta}\right)\boldsymbol{\beta}, \tag{3}$$

Table 2 Definition and descriptive statistics of all variables

Symbol	*Definition*	*Mean (Std. Dev.)*	*Minimum*	*Maximum*
Competition and Spatial Variables				
Samebrand	Number of neighbours with the same brand within the ten nearest neighbours	0.093 (0.291)	0	1
No. of Independents	Number of stations within the ten nearest neighbours that are independent stations	2.053 (1.584)	0	9
Average Distance	Average distance to the ten nearest neighbours measured in driving time in minutes	6.936 (4.766)	0.722	43.204
Branded	Dummy variable set equal to one if the station belongs to one of the ten major brands	0.768	0	1
Dealer Owned	Dummy variable set equal to one if the location is owned by a dealer	0.341	0	1
Location-specific Variables				
Shop	Dummy variable set equal to one if the location has a convenience store	0.764	0	1
24h	Dummy variable set equal to one if the location is operated non-stop	0.189	0	1
Speed: < 40 km/h	Dummy variable set equal to one if the speed limit on the main road next to the location is less than 40 km/h	0.064	0	1
Speed: 40–60 km/h	Dummy variable set equal to one if the speed limit on the main road next to the location is between 40 and 60 km/h	0.727	0	1
Speed: 61–80 km/h	Dummy variable set equal to one if the speed limit on the main road next to the location is between 61 and 80 km/h	0.139	0	1
Speed: 80–100 km/h	Dummy variable set equal to one if the speed limit on the main road next to the location is between 81 and 100 km/h	0.022	0	1
Speed: >100 km/h	Dummy variable set equal to one if the speed limit on the main road next to the location is greater than 100 km/h; Highway stations (baseline category)	0.091	0	1
Attendant Service	Dummy variable set equal to one if the location has an attendant service	0.271	0	1
Size ≤ 800 m^2	Dummy variable set equal to one if the ground surface of the location is smaller than 800 m^2	0.334	0	1
Size: 800–2000 m^2	Dummy variable set equal to one if the ground surface of the location is between 800 and 2000 m^2	0.374	0	1
Size > 2000 m^2	Dummy variable set equal to one if the ground surface of the location is greater than 2000 m^2 (baseline category)	0.266	0	1
Demand Indicators:				
Popdens	Population density of the municipality level in 1000 inhabitants per km^2	1.011 (2.601)	0.001	25.589
Commuters	Ratio of incoming plus outgoing commuters to the population at the municipality level	0.527 (0.105)	0.177	0.828

where β are parameter estimates and $\phi(\cdot)$ is the density of the standard normal distribution. The estimated coefficients, standard errors and marginal effects for the probit model are reported in Table 3.

The estimation model is statistically significant at the 1% level as measured by the likelihood ratio test. The model correctly classifies 72.86% of all observations. Note that 29.66% of all stations actually exited the market. A *naive model* predicting *exit* = 0 would also correctly classify 70.43% of all gasoline stations. The empirical model reported in Table 3 thus reduces classification errors from 29.66% to 27.32%, which represents a reduction in the error rate of around 8%.

The estimation model suggests that exits are more likely for gasoline stations in markets with a low degree of spatial differentiation. Specifically, the probability of exit decreases by 0.5 percentage points as the average distance to the ten nearest neighbours

Table 3 Probit model for the exit decisions of gasoline stations between 2003 and 2011

Dependent Variable: EXIT		*#OF OBS. 2822*		
		Coefficient	*Std. Err.*	*Marginal Effect*
Constant		–1.193	0.348**	
Competition and Spatial Variables:				
Samebrand		0.500	0.148***	–0.187
No. of Independents		0.013	0.018	0.004
Average Distance		–0.014	0.006**	–0.005
Unbranded		–0.180	0.116	–0.060
Dealer Owned		–0.098	0.066	0.033
Location Specific Variables:				
Shop		–0.197	0.110*	0.070
24h open		–0.321	0.079***	–0.104
Speed: < 40 km/h		0.782	0.300***	0.299
Speed: 40–60 km/h		0.747	0.286***	0.229
Speed: 61–80 km/h		0.749	0.325***	0.282
Speed:80–100 km/h		0.894	0.123***	0.343
Attendant Service		0.166	0.067**	0.058
Size ≤ 800 m^2		0.432	0.082***	0.153
Size: 800–2000 m^2		0.334	0.071***	0.117
Demand Indicators:				
Popdens		–0.040	0.012***	–0.013
Commuters		–0.218	0.263	–0.075
LL(β) [LL(0)]		–1558.991	[1715.647]	
LRT		313.31		
Peudo R^2		0.09		
Correctly Classified		72.86%		
False rate for classified as no exit		27.57%		
Classification		*Observed*		
		Exit	*No Exit*	*Total*
Predicted	*Exit*	88	17	105
	No Exit	749	1968	2717
Total		837	1985	2822

Notes: Dummy variables for observations missing from the explanatory variables included. The parameter estimates are significantly different from zero at the *** 1%, ** 5% and *, 10% levels. LL(β) and LL(0) are the log likelihood and restricted log likelihood functions, respectively, and LRT refers to the likelihood ratio test. The *pseudo-R^2* is computed as $R^2 = 1 - \frac{LL(\beta)}{LL(0)}$.

increases by one minute. The parameter estimate for *Average Distance* is significantly different from zero at the 5% level. This result is consistent with empirical studies of price setting in the gasoline market: a high density of gasoline stations is found to intensify competition and reduce prices (Pennerstorfer and Weiss, 2013). Moreover, we find that the number of neighbours selling gasoline under the same brand influences exit rates. As expected, our estimation results suggest that an additional neighbour with the same brand within the local market increases the exit probability of a station by 18.7 percentage points. This effect is significantly different from zero at the 1% level. This finding supports Götz and Gugler (2006) who analyse the incentive of larger retail chains to close outlets as a consequence of a merger. The authors actually find that higher market concentration reduces product variety (as measured by the number of stations per square kilometre). In contrast to Eckert and West (2005), we do not observe a significant relationship between the number of independent stations within the ten nearest neighbours and the exit probability of retail gasoline stations. Eckert and West (2005) find that a greater local presence of independents increases the exit probability of major brand stations. Moreover, they conclude that this finding is consistent with the *independent's hypothesis of rationalisation*. Under the independent's hypothesis, firms unilaterally reduce their station number and improve their remaining stations in response to the presence of aggressive, low-cost independent stations. However, our results suggest, compared with the Canadian gasoline market, that the presence of independent stations in the Austrian gasoline market does not increase competition intensity that much. An explanation for this finding could be that the Austrian market is not that competitive in comparison to the Canadian gasoline market, meaning that independent stations do not act that aggressively. Further, our results provide no evidence for a difference between the exit probability of unbranded and branded stations or between dealer-owned and company-owned stations.

The results reported in Table 3 suggest a tendency towards fewer full service stations (and more self-service stations) as well as more stations with shops. Similar to Carranza et al. (2012), who examine the effect of a price floor in Quebec on station shutdown, our results also suggest that the presence of an attendant service has a significant positive effect on the probability of exit. We find that stations that also feature shops have a 7 percentage points lower probability of exiting compared with stations without a shop. The estimation model includes four dummy variables characterising the location of the gasoline station on different types of streets (stations located on a highway are the reference category). We find that the probability of the exit of stations located on a highway is significantly lower compared with stations located on all other types of streets. Furthermore, smaller stations are more likely to exit the market than larger ones. Consistent with our expectations, we observe a significant and negative parameter estimate for population density. However, the ratio of commuters does not contribute to the explanatory power of our model.

4. Conclusion and Extensions

The present paper examines the exit decisions of retail gasoline stations in Austria over the period 2003 to 2011. One of the key characteristics of this market is that competition is localised; only neighbouring stations directly compete for the same customers. This spatial dimension of competition has to be taken into account when investigating the (binary) decision of whether or not to exit from this business. The results of a probit model estimated on the Austrian retail gasoline sector suggest that the degree of spatial differentiation (distance between gasoline stations) as well as other station-specific and regional characteristics can explain parts of the actual exit behaviour observed during this time period. Our results further suggest a tendency towards fewer full service stations (and more self-service stations) as well as more stations with shops.

However, note that the present analysis focuses on one dimension of the process of restructuring and consolidation in the gasoline sector only: exits of individual stations. Other dimensions, such as the entry of new stations or a merger (and rebranding) of existing stations, are ignored. An interesting extension of the present analysis thus would be to model the different dimensions of structural change in the retail gasoline market simultaneously. Secondly, it is plausible to expect some interrelationship between the exit decisions of (neighbouring) stations. If, for example, two stations compete in a local market, the decision of one station to exit might have a positive effect on its rival's probability of survival and vice versa. This finding implies that not only do the characteristics of a particular station influence its probability of survival but so do the characteristics of its neighbours. We hope that future empirical research along these lines might improve our knowledge of firms' entry and exit behaviour in spatially differentiated markets and thus contribute to our understanding of the determinants of local market power.

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